

DETERMINING IF SPACE IS AN APPLICABLE COMPONENT TO
INTELLIGENCE PREPARATION OF THE BATTLEFIELD
FOR RANGER OPERATIONS WHEN FACING
NON-NATION-STATE ADVERSARIES

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The opinions and conclusions expressed herein are those of the student author and do not necessarily represent the views of the U.S. Army Command and General Staff College or any other governmental agency. (References to this study should include the foregoing statement.)

ABSTRACT

DETERMINING IF SPACE IS AN APPLICABLE COMPONENT TO INTELLIGENCE PREPARATION OF THE BATTLEFIELD FOR RANGER OPERATIONS WHEN FACING NON-NATION-STATE ADVERSARIES by Major Michael Bruce Johnson, USA, 74 pages

This study investigates whether or not space Intelligence Preparation of the Battlefield (IPB) applies to 75th Ranger regimental operations when facing non-nation-state adversaries. IPB includes a process in which military commanders and staff planners perform a systematic and continuous process of analyzing the threat and environment in a specific geographic area. Space IPB is the application of the fundamental principles of intelligence preparation of the battlefield to the subject area of space.

The study identifies characteristics of space and its effects on Ranger and non-nation-state adversary systems. It identifies commercially available space-related resources for use by the Rangers or a non-nation-state adversary. The study then relates space IPB analysis to Ranger operations when facing non-nation-state adversaries by using two separate situational vignettes. Finally, the study assesses specific Ranger systems that necessitate inclusion in space IPB based on the functional relation to space and space effects.

Finally, the study presents the utility in conducting a thorough analysis of the subject area and concludes that space IPB applies to Ranger operations when facing non-nation-state adversaries.

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CHAPTER 1

INTRODUCTION

Background

Space, Enabler for Conflict

Stretched out over the room's floor were two roadmaps, an atlas of the United States (US), and four photographs of two major cities in the US. The photographs were actually satellite images. Two of the photographs were wide area overviews of the two cities from overhead. The other two images were of the World Trade Center complex and the White House. A man by the name of Mohammed Atta would study each image in detail, switching between the two road maps and the five images, pondering his results as he circled significant features on both the maps and images. He and the others had not planned on failing, but if they could not locate the White House as they sped in overhead, they knew they could locate the Pentagon. The Pentagon stood relatively alone and marked a tremendously large target. To be sure though, Mohammed Atta would buy one more image. His fingers traced the corner of one of the images until it stopped at some printing in the corner. The printing read www.spaceimaging.com.

On 11 September 2001 the adversarial complexion of the world had forever changed. Although the events described in the preceding paragraph are contrived from the mind's eye, the events reflect only one of the many very real space-based resources available to the nation's adversaries. In this case the adversaries are alleged to be from the Al Qaeda organization, led by Osama bin Laden. How could a non-nation-state entity bring such a nationally debilitating attack into the heart of the US? Perhaps this attack was executed with limited planning and preparation and the targets were selected

haphazardly with little or no target analysis. Perhaps an attack of this nature was planned and executed after significant planning, preparation, and analysis. In any case, this adversary challenged the demonstrated technological military might of the US.

Operation Desert Storm brought much of the US technological military might into full view of the world. The clarity of satellite images showing the disposition of critical Iraqi assets, both before and after these assets were destroyed, offered widespread public insight into US military capabilities. Images displayed from aircraft vectoring laser-guided munitions with pinpoint accuracy made it apparent that it was virtually impossible to hide or protect anything from being targeted for destruction. Optically guided munitions allowed the public to witness the capability of putting a bomb through the rooftop vent of an Iraqi building. The television broadcasts of all these technological military advancements made war appear distant and clean. The Iraqi military, with many of the most advanced Soviet-made weapons, was of little consequence to the technological military might of the US and its coalition partners. Much of this military might is associated with space and space-related systems. These new conflict-demonstrated technological advancements would not go unchallenged.

Shortly after successful military operations in the Gulf War the US would take on a much less technologically savvy force than the Iraqi's. However, technological inferiority had nothing to do with success of that force. Mohammed Farrah Aidid would prove to be an elusive target for Ranger forces, and the recently displayed technological military might of US forces during the Gulf War was of little consequence.

Prudence expects that US adversaries have reassessed their military capabilities, strategies, and political postures. In the near term, intelligence analysts assess lesser

degrees of threat from conventional national military encounters and greater threat from asymmetric encounters, that can include human sacrificial bomb attacks against civilians, kidnappings, and computer network attacks. Not only are these encounters asymmetric in nature, but the adversaries themselves are also more often asymmetric than conventional nation-state adversaries. Another developing theme amongst analysts is asynchronous warfare. Analysts suggest warfare will be directed against the US at a time and place of an adversary's choosing, rather than at a period of US choosing, when the US can dictate tempo and application of force. US vulnerability will be exploited at airports and seaports, both at ports of debarkation and embarkation. Adversaries will attack US reliance on technology. The US can expect adversaries to hide amidst population centers, where US determination to engage targets is hampered. As witnessed during the Kosovo air war, both high-technological deception techniques, like electronic spoofing, and low-technological deception, like inflatable tanks, will become more prevalent. This will tie up satellites, aircraft, communications, analysts, and numerous other assets in determining a target's viability. Much of the US military's extraordinary lethality, precision, and strategic reach relies on a multitude of space-based platforms. US adversaries recognize this reliance with the same acuity as the precision weapons. Historically the US has been able to adapt to the changing environment. However, will the US adapt in advance of adversaries, or will a catastrophic loss obviate changing military methodologies?

For about the past fifty years the US has been pursuing efforts to determine what benefits await mankind in the upper reaches of space. Exploration of the terrestrial and extraterrestrial worlds has been a continuing endeavor for mankind. Whether the

medium is exploring the depths of the oceans or the far reaches of what lies beyond the horizon, exploration draws mankind to seek the unknown, sometimes for exploration's sake alone, but often with the intent of discovering something or someplace that will be beneficial to the effort. Much of the exploration throughout history has been done by military personnel, and often with militaristic intent.

During World War II the Germans were attempting to develop the V-series weapons. The intent for this rocket was to carry a military payload to its intended target. Although inaccurate as a weapon of war, it was still extremely effective. The mere thought of a rocket that could carry a warhead was a terrifying concept to Germany's enemies. The Allies had virtually no way to defend against these new weapons. Subsequently, a primary strategic push developed to gain the scientific knowledge necessary to develop rockets, as well as the ability to counter these new weapons systems. Concurrently, all parties were attempting to develop weapons out of what at the time was only the theoretical ability to develop nuclear weapons. Scientists and military leaders were acutely aware that the marriage of nuclear weapons payloads with that of rocket technology was a terrifying thought, and would give a power that had the technology a crucial, indefinable advantage in the strategic use of power.

After World War II, both the Soviet Union and the US actively pursued scientists who had either or both the technological and scientific expertise necessary to be the first to apply the awesome destructive capability of nuclear weapons payloads to rocket delivery platforms. The country that wielded the combined technological expertise to launch virtually indefensible intercontinental missiles with nuclear payloads would be the

preeminent superpower. Being the first to master this capability became the national goal of both countries. The results of this pursuit would push man into space.

In 1957 the Soviet Union developed and launched the world's first satellite into space (Gregoire 2000, 22). From that defining event the race to space had started in earnest. President John F. Kennedy pledged the US would place emphasis on getting man into space and to the moon. The significance for the US to do this was not just national pride, although putting a man onto the moon significantly contributed to the nation's pride, let alone the sheer wonder of exploring areas out of this world. Rather, the significance was control of the capacity to operate in the new environment of space and the ability to exploit the resources offered by the new frontier. The bird's-eye view from space made it apparent that this technical capability could be used for intelligence, communications, and support operations (Collins 1989, 1).

The utility of using space as an area of operations for military objectives is apparent. Space itself is vast, and its reaches are undefined. The holistic utility of space to the military is equally vast and undefined, but nevertheless critical to current US national and military strategy. Intelligence is a critical functional area of military planning and operations development. Intelligence preparation of the battlefield (IPB) is the process by which the military intelligence community systematically analyzes the threat and environment in a specific geographic area. Designed to support staff estimates and military decision making, IPB helps the commander selectively apply and maximize his combat power at critical points in time and space on the battlefield through a continuous process of analysis (US Department of the Army 1994a, 1). Equally important to commanders, special operations forces, such as the Rangers, have unique

characteristics that give the added flexibility necessary to successfully accomplish the missions conventional forces are incapable of executing.

Special operations forces are characterized by attributes that distinguish them from conventional forces. They may be used against targets that have a high degree of physical and political risk, and may be directed against high-value targets. The operations rely on surprise, security, and audacity, and frequently employ deception in order to achieve success. The missions often offer the opportunity for high returns on success, but, if failed, can rarely proffer a second attempt. Special operations forces normally require operator level planning and detailed intelligence and knowledge of the target area of operations. Special operations forces' missions are often conducted at great distances from operational bases, necessitating robust communications, mobility, and support capabilities. Finally, special operations forces require precision, discriminate use of force and weapons, and equipment that is often not standard to conventional forces (US Military 2000, 4).

Rangers, like other special operations forces, are unconventional by design and are likely to be used against other unconventional forces or for missions that conventional forces just do not have the capability to do. As previously noted, today's threats are no longer just nation-state militaries. Rather, today's threats include asymmetric threats, like terrorists or drug traffickers, and may or may not be state sponsored. When the terrorists or drug traffickers receive assistance from a state sponsor in support of operations, then resources, training, and capabilities are even more robust. Additionally, the advent of commercially available space-related information to anyone with a credit card and Internet access has improved the capabilities of asymmetric threats. Compounding this

phenomenon is the fact that since the collapse of the Soviet Union, and given their dire economic straits, scientists started leaving the country to find employment and research resources elsewhere. Commercially available information, coupled with scientific expertise for hire, has enabled the asymmetric threats and made them more viable. The added flexibility and viability of the enabled asymmetric threat potentially make it more lethal, and create a significant adversary to the intelligence community. Equally, the Ranger commander who is saddled with countering the asymmetric adversary on the battlefield will want to consider that adversary's enabling resources.

While a non-nation-state adversary's enabling resources are varied, one particular resource that merits consideration is the commercial space industry. The commercial space industry has seen significant growth and subsequent use of many commercial systems. There are three particular space systems that have become commercially available. These systems consist of satellite-based navigation, communications, and imagery. First, global commercial satellite communications systems have become one of the most widely recognized commercial space industry resources available, and include the likes of Iridium, Globalstar, and ICO Global Communications. Equally, there has been significant growth in commercial navigation, otherwise known as global positioning systems. The third system includes imagery and is perhaps the least publicly familiar commercially available space industry system (Karpiscak 1998, 2). Each of these enabling resources merits further analysis to determine its potential impact on Ranger operations.

Only the financial capacity to acquire and the degree of technical expertise to fully exploit the enabling resources determine an adversary's ability to completely make

use of the many space-based enabling resources available. Arguably, the complete synergistic exploitation of all commercially available resources reflects a significant enabling resource. Availability of these products makes them a source for analytical consideration in the IPB process. An amplifying characteristic of the utility of space-based information is the fact that the information can come in near real time (Gregoire 2000, 262). This gives an advantage to adversaries in that they would have an easier time of getting within the Ranger force's decision-making cycle and influencing results in favor of the adversary. This advantage would significantly hamper the Ranger force's surprise and flexibility.

Ranger forces, as do most special operations forces, routinely rely on surprise as a critical factor for success, and train to maximize operational flexibility in the Ranger leadership. An adversary's ability to favorably exploit commercially available space-based resources, such as global positioning system navigation, satellite communications, and commercial imagery, could significantly hamper Ranger operational flexibility. As a simple illustration, an adversary's use of commercial imagery, combined with any other enabling information, becomes that adversary's intelligence product and could depict a possible adversary capability necessitating consideration in the Ranger's IPB process.

The intelligence community is just beginning to get comfortable integrating space IPB into joint operations, and the knowledge of space IPB is only recently being integrated into the program of instruction for junior intelligence professionals. Furthermore, there exists a chasm of professional intelligence expertise in the integration of space IPB across the full spectrum of conventional strategic, operational, and tactical operations. It should be noted that, although a capabilities gap exists between space IPB

expertise and the field population of Army intelligence professionals, that gap is dwindling, albeit not rapidly. Ranger officers are selected from the field Army. If a chasm in space expertise or experience exists in the field Army, then the space knowledge void is carried over into the Ranger regiment. Because Rangers are called upon to execute missions that other conventional forces cannot do, and the fact that the level of precision needed to conduct special operations missions necessitates detailed intelligence, the chasm of space IPB expertise applied to Ranger operations becomes even more precipitous.

In summary, the nature of this problem is multifold. First, the general understanding of space as a component of IPB is limited, and intelligence professionals are not necessarily inclined to analyze it as a part of the IPB process. Next, if space is overlooked as a component of IPB, then the evidentiary effects of space in the IPB process on friendly and enemy forces are never considered. Third, compounding effects of the two previously mentioned problems means Ranger intelligence professionals are not including space as a component in the process of analyzing the entirety of effects on the whole of Ranger operations. This lack of understanding, amplified by the expanding use of space-related commercial resources, could leave the Ranger commander dangerously unaware of the implications of space IPB on his operations.

Problem and Fundamental Question

According to both *A National Security Strategy for a Global Age* and *Joint Vision 2010*, the foundation upon which a peaceful world can be built is US ability to bolster existing international alliances and develop new alliances with our global partners. US ability to influence national competitors consistent with the nation's strategic goals, deter

aggression and coercion against the United States and its allies, and, when necessary, defeat the nation's adversaries when called upon to do so are an enduring strategy. Expanding military alliances and enhancing interoperability with US military partners will achieve sustaining balance in key regions (US Department of Defense 1996, 5). The US Armed Forces' ability to maintain a strategic advantage over the rest of the world's military adversaries and achieve the goals of this strategy requires sustaining a favorable military balance in some key regions and across critical functional areas of our nation's military adversaries.

Sustaining a favorable balance in critical functional areas requires that the US must sustain and develop military capabilities to maintain the advantage and deter potential aggressors. These national capabilities include the need to exploit existing opportunities from innovations in space, intelligence, and special operations forces. While the US military is currently exploiting innovations in the areas of space, intelligence, and special operations forces, it sometimes falls short in analyzing the possible benefits and potential impact of their complete integration. An integrated analysis of space, intelligence, and special operations forces will aid in determining the benefits and impact on military operations. Failure to understand and exploit the knowledge gained from this analysis means unnecessarily accepting risk. The scope of analyzing space, intelligence, and special operations is extraordinarily broad; therefore, this thesis will seek to examine how space, as a component of IPB, applies to non-nation-state adversaries and the 75th Ranger Regiment's operations. To do this it is necessary to describe some representative examples of non-nation-state aggressors, describe environmental aspects of space that affect military use, discuss commercially available

space systems, discuss characteristics of space IPB, and discuss unique nuances of Ranger operations, and then, upon understanding these areas, relate space IPB to Ranger operations both from an adversarial and friendly perspective. Finally, discussion will include the specific Ranger systems that necessitate space IPB.

It bears noting that some contributing delimitations exist with respect to the scope of this thesis. First, additional information relevant to this topic exists at the classified level. However, this thesis will remain unclassified and will exclude relevant classified research and sensitive operations that may affect results of the thesis topic. The primary intent behind this approach is to maintain the widest distribution for possible academic development and professional consideration. Next, this research will only address Ranger operations and may or may not be applicable to other conventional forces. The aforementioned delimitations do not preclude the relevance of discussion of the thesis topic.

In addition to these delimitations there are some significant limitations that exist. This research will largely be restricted to the time limitations of the degree program and preclude expertise that was expected to be available prior to the 11 September 2001 terrorist attacks on the World Trade Center and the Pentagon. This research began prior to the 11 September attacks and presupposed availability of some resources. As an example, in response to the terrorist attacks Ranger points of contact are either too busy planning operations in response to the aforementioned attacks or are deployed for other reasons from their home stations.

To clarify the research, some fundamental assumptions must be addressed. There is a difference between space IPB at the strategic level and space IPB at the tactical level.

The notable difference is primarily in the level of detail. Additionally, the functional expertise necessary for space IPB resides at the corps level and is not resident in the 75th Ranger Regiment. Equally, there are significant differences for Ranger operations as opposed to conventional operations. We will delve into that greater understanding of the necessity of space IPB for Ranger operations, which, as indicated earlier, may or may not be applicable to conventional forces. Furthermore, this thesis supposes that space will continue to expand in its relevance to military capability. Subsequently, the functional areas that share a relationship with space will continue to develop as well. In this case the primary discussion will lead from a current understanding of the functional areas of space and IPB towards a look to the future for developing space IPB in order to determine if it affects Ranger operations.

The immediate relevance of this topic in the scope of world events and military activities is self-evident. The terrorist attacks of 11 September 2001 have left little doubt as to the realities of the impact of non-nation-state aggressors against the United States. Equally apparent is the use of the 75th Ranger Regiment in countering adversaries of this nature, as witnessed by its employment in Afghanistan against the alleged perpetrators of the 11 September attacks. The uniqueness of this topic lies in the application of space as a component of IPB for the Rangers as they are employed against the alleged sources of the attacks. While the concept of space IPB is not necessarily new, the view towards the impact on Ranger operations will hopefully prove to be innovative.

CHAPTER 2

LITERATURE REVIEW

Developing the Army's strategy, tactics, diplomacy, policy, and procedures, based on the requirements outlined in *A National Security Strategy for a Global Age* and *Joint Vision 2010*, necessitates study of the topic of space and IPB across the full spectrum of military operations. Certainly, current events dictate the continuing need to study space and IPB as they relate to Ranger operations. As discussed in chapter one, the general understanding of space as a component of IPB is limited, and the preponderance of military intelligence professionals is not necessarily inclined to analyze it as a part of the IPB process. Space is often overlooked as a component of IPB, and the evidentiary effects of space in the IPB process on friendly and enemy forces are never considered. Considering the expanding availability and use of space-related commercial resources and the nature of non-nation-state adversaries, Ranger intelligence professionals who exclude space as a component in the process of analyzing the potential effects on operations can leave the Ranger commander dangerously unaware of the implications of space IPB on his operations.

In general, the status of available literature specifically focusing on space IPB is best characterized as being in the developmental phases. However, there is a great deal of available literature on space, the space environment, effects of the environment on space-related systems, and other influential characteristics of space. Included in the literature are resources that can be accessed for analytical inclusion. Equally, there is an abundance of literature available on the function of IPB at the strategic, operational, and tactical levels. The goal will be to interrelate the available literary information into a

more developed understanding of space IPB, determine the availability of space-related information from the perspective of potential adversaries, and assess space-related Ranger systems. In the end, the thesis will seek to determine the scope of applicability of space IPB to Ranger operations.

Initially the thesis will be developed from a requirements-based perspective. The sources of this requirements-based perspective are derived from both of the most current versions of *A National Security Strategy for a Global Age* and *Joint Vision 2010*. *A National Security Strategy for a Global Age*, which includes input from the Joint Chief of Staff's *National Military Strategy*, assesses a broad range of considerations from which requirements are derived. Considerations from which requirements are derived include, but are not limited to, the military environment, the economic environment, the political and diplomatic environment, health and environmental aspects, international laws, and arms control and nonproliferation. The requirements-based approach allows this topic to comprehensively proceed from the needs to developing and implementing the plans. The enormity of the needs and plans is grossly understated when out of this are derived the strategy, tactics, diplomacy, policy, and procedures yet to be developed. Additionally, Department of the Army field manuals and Department of Defense vision outlooks highlight the path the military is marking as a guide to developing the interrelationship of space and the military.

From the requirements-based perspective the thesis will evolve to review some historical occurrences and associated technical background pertinent to developing the topic. Some resources available to this endeavor include: *Military Space Forces: the Next 50 Years*, a summary of research by John M. Collins, commissioned by the US

Congress, which by design would be a tool to help Congress and the Executive Branch make space-related decisions involving US national security, and *The Future of War*, by George and Meredith Friedman, that discusses how innovations in technology will affect future defense strategies. From this text many of the baseline terms are extracted. Both works discuss space, intelligence, and the synthesis of analysis necessary to prepare for the future of space policy, national security and defense strategy, and future warfare. Additionally, *Space Power Theory*, by James Oberg, analyzes space from a macro-IPB perspective amidst his discussion of space and its relevance to national power. This is to say that included in his book are the considerations of space as it applies to the operational environment, yet given the sheer vastness of space this descriptor hardly seems all encompassing. Still, Oberg discusses aspects of space and elements of space analysis that bear directly on the strategic and tactical level of military operations. Finally, the *Army Space Reference Text 2000* is a compendium of reference materials about space-related topics as they relate to US Army operations, and is intended for use by US Army personnel. This compendium of reference material is a significant resource to the military professional, covering a broad array of topical information on space and the interrelationship to the US military. The text is just what its title indicates, a reference for a multitude of other related analytical works, assessments, articles, lists, and sources of information pertinent to Army space issues.

All pertinent joint publications, current and developing Army doctrinal manuals, and compendiums of work from the US Army Space and Missile Defense Command will be utilized in the development of this thesis. Relevant components of operations, space, and IPB taken from Field Manual 100-5, *Operations*; Field Manual 100-18, *Space*

Support to Army Operations; and Field Manual 34-130, *Intelligence Preparation of the Battlefield*, will serve as the referential foundation for the analytical application of space IPB to Ranger operations. Furthermore, applicable information from US Army Space and Missile Defense Battle Lab, US Army Special Operations Command, the 75th Ranger Regiment, and the Center for Army Lessons Learned will be applied to this thesis.

The sources of literature available on space and its relationship to the military are expanding. However, a great deal of research remains to be developed to fully understand the subject areas of space and the military and their interrelationship. The topic of space IPB is only now being more fully integrated into the Army's intelligence curriculum. Given the developmental nature of space IPB as a topic in and of itself, and the application of space IPB to Ranger operations, the thesis will seek to foster thought and discussion in the continuing analysis of this particular subject area, as well as that of related subjects. In order to provide adequate time for analysis, the period for reviewing and analyzing available sources of information will terminate at about the December 2001 time frame. After this time frame, considerations for inclusion of newly encountered information into the thesis analysis will be given on a case-by-case basis.

CHAPTER 3

RESEARCH METHODOLOGY

The research methodology for this thesis is comprised of multiple phases in determining how space IPB applies to Ranger operations. The analysis will include examination of all available resources appropriate to answering the thesis question and the associated supporting questions. Phase I will utilize a comparative examination of space IPB, utilizing situational vignettes as a basis for assessing space as a component to IPB for Ranger operations, and will discuss space IPB exclusively from a non-nation-state adversarial perspective. Finally, Phase II will address Ranger systems which have space-related applications.

As previously indicated, the paper will seek to analyze all pertinent information relative to the topic within the time limitations available to the author. This will include for purposes of this paper, identifying the requirements that necessitate space IPB and defining space as it applies to military operations. Additionally, the analysis will include considerations of the developing framework of space IPB in order to develop representative analysis for space IPB of Ranger operations.

The development of Phase I of this thesis will seek to utilize information obtained during examination of the available material, coupled with a comparative examination of space IPB utilizing situational vignettes as a basis for assessing space as a component to IPB for Ranger operations, in order to define the framework of discussion. From that baseline the paper will use the vignettes of Ranger operations to identify the impact of commercially available space-related resources and analysis that could be utilized by adversaries. The research will also seek to determine if the application of space in the

IPB process could have determined through analysis both friendly and enemy aspects for consideration by Ranger planners.

Finally, Phase II will seek to identify space-related systems used by the Rangers. In a multistep process the research will determine if there are specific effects on these systems which merit consideration during space IPB. For example, are the Ranger systems susceptible to intercept, jamming, deception measures, or the space environment effects? If possible, the potential origin of the effect will be analyzed to determine if mitigating measures can be taken into consideration. For example, space weather events, like solar flares, necessitate planning considerations for use of, or the potential for intercept, and jamming necessitates using proper radio procedures (Frooninckx 1998, 28).

Each phase of this analysis will be guided by the following general research question outline:

1. Does space IPB apply to 75th Ranger regimental operations when facing non-nation-state adversaries?
2. Are there notable differences in conducting IPB and space IPB for Ranger operations when facing non-nation-state adversaries that merit the inclusion of the subject area of space?
3. What space-related open-source or commercial information is available to non-nation-state adversaries?
4. What Ranger systems should be included during space IPB?

These research questions provide the framework for a comparative examination of space IPB, utilizing situational vignettes as a basis for assessing space as a component to IPB for Ranger operations. The research will seek to produce analysis spanning all of the

battlefield operating systems. Tables of organization and equipment will be used to list Ranger systems considered in space IPB. Additionally, knowledge and personal experiences of former Ranger-unit members, in conjunction with the technical expertise of professionals and cadre at the Army Command and General Staff College, will be used to generate substantive discourse on the thesis topic. This dialogue will not be used for resultant analytical purposes unless otherwise noted.

The aforementioned discourse will also be used to develop the representative vignettes, which will include overviews of both the friendly and threat situation. These vignettes will be used as a foundation for the comparative analysis and may include fictional aspects to the friendly and threat situations in order to develop the topic. When possible the vignettes will be framed around actual events so as to provide a more tangible understanding of the comparative analysis.

It is recognized that a comparative analysis approach to this kind of research may produce analytical results that by themselves appear trivial. The analysis may produce results that appear to have a negligible impact when presented in and of themselves, but when included as a part of a broader piece of analytical work aid in crystallizing the perspective. Metaphorically speaking, one piece of a jigsaw puzzle by itself is insignificant, but when joined with other pieces can be conclusive in producing the completed work. Bits of information, when coupled with other information, can become a critical and subsequently a very tangible aspect of the greater intelligence picture. The strengths of this research methodology are that it is based on a systematic and continuous process of analysis with which many military professionals are familiar, IPB (see figure 1). Additionally, the IPB process is a proven and effective process, which makes it an

effective tool around which to develop this research topic. In effect, the methodology will take the proven and effective process of IPB and apply space as an added subject area for analysis. Finally, in order to supplement the available published information, and in many cases to bridge the gap of unpublished information, the methodology incorporates information that includes the knowledge and professional expertise of those at the Army Command and General Staff College.

The weakness of this research methodology exists in the vignettes. First, in order to focus the research analysis on representative aspects for consideration, fictional situations are described amidst factual events. This may produce results otherwise not achievable in a wholly factual vignette, the results of which could taint their overall validity. Second, the methodology is structured around a singularly represented framework of analysis, Army IPB with space as an added subject area for analysis. Subsequently, other frameworks of intelligence analysis could produce divergent results.

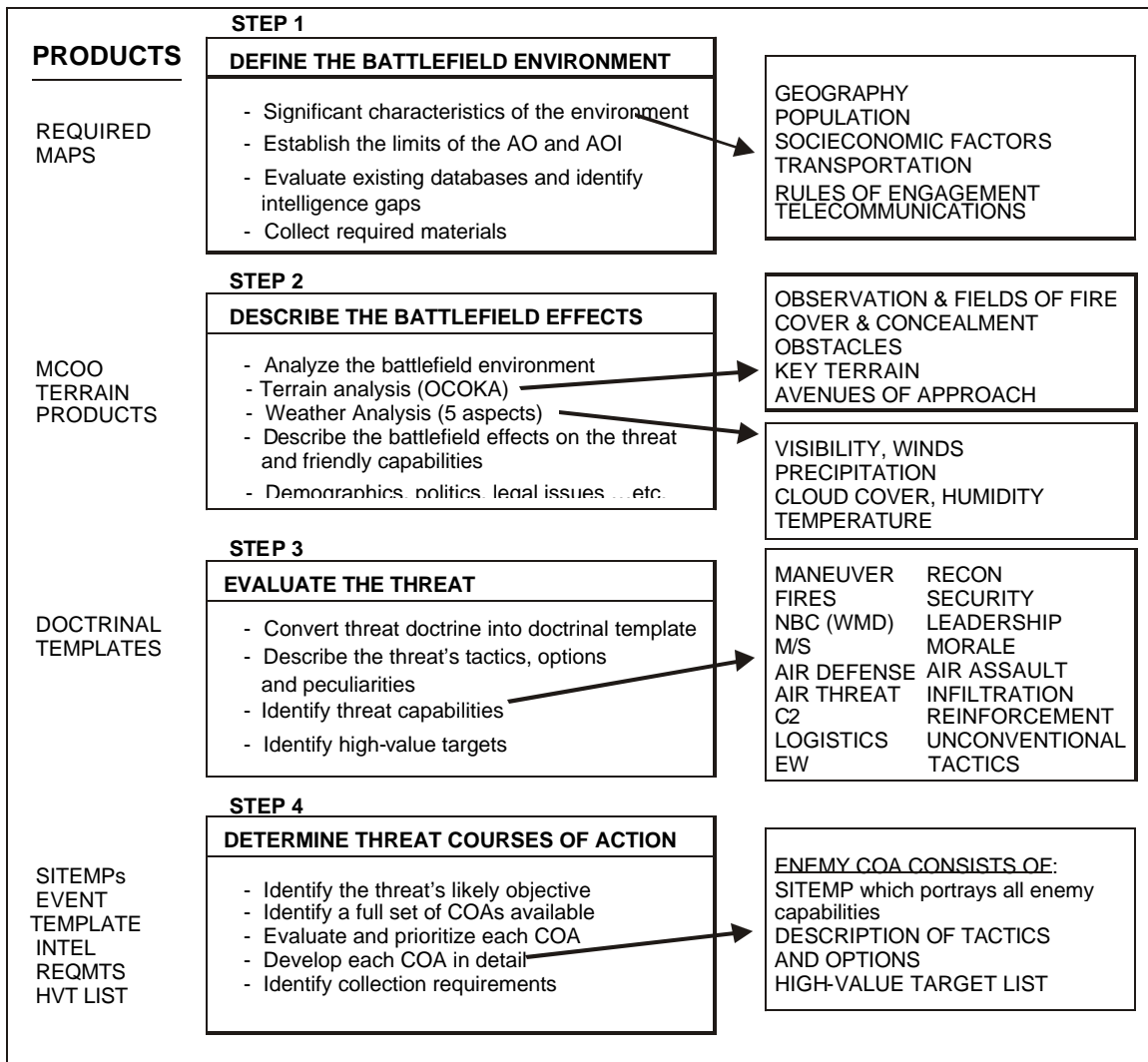


Figure 1. Four-Step IPB Process. Source: FM 34-130/MCRP 2-12A 1999, 1-8.

CHAPTER 4

ANALYSIS

This chapter will perform analysis in multiple phases to determine if space IPB applies to 75th Ranger regimental operations when facing non-nation-state adversaries. As indicated in the previous chapter, analysis begins with an examination of all available resources appropriate to answering the thesis question and the associated supporting questions. Next, Phase I of the analysis will utilize a comparative examination of space IPB, utilizing situational vignettes as a basis for assessing space as a component to IPB for Ranger operations. Finally, Phase II of the analysis will identify space-related systems used by the Rangers that merit consideration for space IPB analysis. In developing a more salient understanding of the subject it is first necessary to describe some representative examples of non-nation-state aggressors, describe environmental aspects of space that affect military use, discuss commercially available space systems, and discuss characteristics of space IPB (Note: although a rudimentary explanation covering the highly technical information included in environmental aspects of space IPB is provided, the explanation of the physical causative effects of the interrelationship between the sun and Earth should be sufficient enough to understand the topic). Furthermore, this chapter will relate space IPB to Ranger operations, both from an adversarial and friendly perspective.

Each of the situational vignettes was chosen because it is loosely based upon actual events that included both the 75th Ranger Regiment and non-state-sponsored adversaries. This approach was taken to ensure some degree of topical familiarity between the reader and the thesis subject. While the primary event from which the

vignettes are based did occur, the characterization of the surrounding events may or may not be wholly factual. It is important to note that the vignettes are primarily an illustrative tool from which the comparative analysis will be developed and are not intended to be a declaration of facts as they occurred. With that being said, the two vignettes chosen include discussions relevant to combat operations conducted by Task Force Ranger in Mogadishu, Somalia, and the current events developing from the terrorist attacks on the World Trade Center and the Pentagon on 11 September 2001.

This thesis will only address non-nation-state aggressors operating without resource complicity of nation states. For purposes of this thesis, safe haven is not included in the definition of a nation-state's resource complicity. To that end, this thesis considers such non-nation-state aggressors as individuals or organizations in the vein of terrorist organizations, drug cartels, organized crime organizations, criminals, and other entities who have been identified as threats hostile to the US's implementation of its national goals and objectives (such as persons indicted for war crimes). Rangers have been used as an instrument of force against many of the aforementioned types of non-nation-state aggressors. Examples of non-nation-state aggressors have included the likes of Mohammed Farrah Aidid and Osama bin Laden. As previously indicated, the comparative analysis used to determine if space IPB applies to Ranger regimental operations will be developed from situational vignettes covering events that will include these two non-nation-state aggressors.

While Ranger forces do not operate in space, they undoubtedly utilize systems that are related to space. Equally, non-nation-state adversaries utilize systems that are related to space. Understanding the environmental aspects of space that impact Ranger

operational use will serve to develop the topic. While there is no single definition of space, the thesis will start with how the *Merriam-Webster Dictionary* defines it; space is the limitless area in which all things exist and move (Woolf 1974, 658). While certainly an all-encompassing definition, it is a little too broad for the purpose of this thesis. This can be simplified a bit by using one of the qualifying definitions from the *Merriam-Webster Dictionary* that says space is the region beyond the Earth's atmosphere. There are numerous definitions for the boundaries of space, whether the definition is used for defining international treaties, international law, or scientific analysis. The definition this thesis will utilize is what is recognized by the US government and is based on international law standards. Without mentioning a specific altitude, international law defines the lower portion of space as being the point where an orbiting space vehicle can achieve its lowest perigee. By international law standards anything flying over a country is considered to be in that country's national airspace, regardless of altitude. An orbiting space vehicle is said to be in space regardless of a definable altitude. The definition hinges on a space vehicle's capacity to achieve its lowest orbit around the Earth (Gregoire 2000, 34).

Adjacent to and overlapping the lowest boundary where space is defined is the Earth's atmosphere. The Earth's atmosphere, in turn, is divided and subdivided into numerous regions which themselves have limited definable boundaries. It is difficult to associate an altitude with a region's boundary because the regions are constantly morphing in size due to a number of factors that include, but are not limited to, the time of day, seasons of the year, and the degree of solar activity (Gregoire 2000, 35). The Earth's atmosphere includes the troposphere, stratosphere, mesosphere, thermosphere,

exosphere, ionosphere, and magnetosphere. Understanding the juxtaposition of the individual regions will aid in accentuating the regional characteristics and activities that could have an influence on Ranger or non-nation-state adversary operations.

The regions of the Earth's atmosphere which are most familiar are the troposphere and stratosphere. The troposphere is the region of the Earth's atmosphere closest to Earth and contains almost all the clouds and terrestrial weather that occurs. The effect of atmospheric weather has a direct impact on military operations and equipment efficiency, namely communications equipment. The layer above and adjacent to the troposphere is the stratosphere. The ozone layer is present in this region and is important because it absorbs much of the sun's harmful ultraviolet radiation, which has a direct impact on humans. Although these regions represent the most familiar regions of the Earth's atmosphere, the remaining atmospheric regions merit description and understanding for their potential effects on operations.

The next significant regions of the Earth's atmosphere include the mesosphere, thermosphere, exosphere, ionosphere, and magnetosphere. The mesosphere is located at about thirty to fifty miles above the surface of the Earth and marks the cessation of temperature inversions which occur in the stratosphere. Adjacent to the mesosphere is the thermosphere, which marks the region where space begins. Next is the exosphere, which is characterized as the upper limits of Earth's atmosphere and which marks the region where the atmosphere's molecular density is extremely low. Beginning in the mesosphere, the ionosphere is characterized by the high density of ionized molecules that are directly impacted by solar activity. Solar activity, like sunspots or solar flares, causes fluctuations in the ionosphere and directly affects high-frequency radio propagation.

Finally, the magnetosphere is an area that overlaps with the ionosphere and is controlled by the Earth's polar-generated magnetic field. Affected by solar activity, the magnetosphere has a direct impact on satellite communications (Gregoire 2000, 38; Collins 1989, 15). Rudimentary definition, juxtaposition, and explanation of these regions is necessary to understand the significant effects that solar activity, electromagnetic activity, and radiation have on Ranger's and non-nation-state adversary's space-related systems.

The first significant effect to be discussed is solar activity. The impact that the sun's activities have on the space environment is far reaching. The sun is continuously radiating electromagnetic energy and electrically charged particles combined with electromagnetic radiation, forming constant streams of radiation called solar wind. During periods of gusty solar wind, powerful magnetic storms in space near the Earth cause vivid auroras, radio and television static, power blackouts, navigation problems for ships and airplanes with magnetic compasses, and damage to satellites and spacecraft (Hathaway 2001b, 1). At the same time, there are occurrences of explosive ejections from the sun, known as solar flares. Solar flares occur at irregular intervals and are characterized by particles of protons and electrons that are accompanied by the sporadic emission of electromagnetic radiation (Gregoire 2000, 39). Solar wind energy in the Earth's magnetosphere can also cause what are known as space plasma storms, which can cause communication and science satellites to fail. They can also cause damage to electric power systems on the surface of the Earth (Six 1996, 1-3).

Even though directly related to solar activity, electromagnetic forces present in the Earth's atmosphere are distinct in that the Earth's magnetic forces seem to originate

from deep within the Earth's core. Although not fully understood, magnetic fields are thought to be generated from the electric currents circulating within the Earth's molten core. The Earth's magnetic field extends outward into space where it encounters both the sun's own magnetic field and solar winds (Gregoire 2000, 43). In simple terms, the powerful solar activity from the sun causes the Earth's magnetic field to morph. Herein lies a rudimentary explanation of the interaction between the sun's activities and those of the Earth's magnetic field.

The Earth's magnetic field controls electrically charged particles in motion within the magnetosphere, and it is within the magnetosphere that the Van Allen radiation belts are found. The Van Allen radiation belts are comprised of regions of electrons, protons, and other energetically charged particles trapped when the charged particles encounter Earth's magnetic field within the magnetosphere. The regions of the radiation belts are dependent on both the sun's activities and the magnetic field of the Earth, and the intensity of the radiation is based on the disposition of the energetically charged particles within that region. The intensity of the radiation can affect spacecraft traveling through these regions, known as the Van Allen belts (Gregoire 2000, 45). Subsequently, the combined effects of electromagnetic radiation from the sun's solar activities in the form of solar winds and solar flares interact with those of the Earth's electromagnetic activities to create effects, among which are the Van Allen radiation belts. The interrelationship of effects can have a tremendous impact on a multitude of man-made Earth and space-based systems.

Having an understanding of the forces of solar activity, electromagnetic activity and radiation is necessary for developing an understanding of causal effects. Effects

from these forces on space-related systems are directly related to an individual activity or the simultaneity of activities. When discussing these activities and their effects on space-related systems, it is necessary to include the holistic effects. A single activity, like a solar flare, will have an effect all its own. Yet, as is often the case with these forces, one activity can influence other forces, compounding effects on space-related systems. For example, a significant solar flare will have an impact on the Earth's electromagnetic field. Consequently, a singular causative solar-geophysical activity can compound the effects on space-related systems (Gregoire 2000, 39). In understanding the individual and compounded effects of solar and Earth-geophysical activities, it is helpful to discuss some sample system effects. The sample system effects include, but are not limited to short-wave fade, radio wave interference, high-energy particle effects, ionospheric scintillation, total electron content, and radar clutter and interference.

Solar activity and the associated geophysical activities can account for a series of effects on electronic systems. Communications can be affected by a dynamic known as short-wave fade events. Short-wave fade events are caused by solar flare X-rays (see definition). High-frequency radio is also known as short-wave radio, because of the relative short-wavelength frequency. Short-wave fade refers to the degree of absorption of a high-frequency radio signal entering into the Earth's atmosphere during transmission. Scientists have long recognized that short-wave fade is associated with solar flares, and since solar flares can be monitored the resultant propagation and effects of short-wave fade can be anticipated. Satellite communications and radars can experience interference from increases in radio wave energy emitted following a solar flare. A solar flare can also produce high and low energy particle emissions, which can produce impacts, such as

satellite disorientation, physical damage to space-based systems, false sensor readings, navigational system errors, absorption of high-frequency radio signals, spacecraft electrical charging, drag on low Earth orbiting satellites, radar interference, space-tracking errors, and radio wave propagation errors (Gregoire 2000, 48).

Solar activity, electromagnetic activity, and associated geophysical activities can create numerous irregularities impacting space-related systems. These irregularities may include scintillation, total electron content, radar clutter, and interference. Radio wave signal scintillation can result in signal fade and data dropouts on satellite communications data uplinks and downlinks. Furthermore, scintillation affects navigation satellites by interfering with the same system data links as communications satellites (Gregoire 2000, 50). Total electron content can impact space-related systems by producing positional errors by distorting the signal in navigational systems affected by the total electron content along the signal path. Geomagnetic and ionospheric storms can produce abnormal radar signal backscatter, as well as false radar signatures. Since solar activity and the associated effects manifest these events, many times the effects are limited to objects within a direct field of view of the sun. Additionally, the solar events can be monitored to provide a degree of predictive preparation before the impending effects on electronic systems occurs, and at the same time the systems operators can make a reasonable assessment of causative effects after the occurrence. Although rudimentary, the explanation of the physical causative effects of the interrelationship between the sun and Earth should be sufficient to draw some associative conclusions.

An elementary understanding of some of the technical aspects of satellites and the associated terminology follows. Suffice to say that, according to the laws of physics,

satellites move and behave in a predictable manner. Satellites orbit the Earth in various orbital patterns and are held in that orbit by the Earth's gravitational dynamics. The satellite will remain in that orbit until external factors begin impacting its track. Gravity and atmospheric drag are just two examples of some of the external factors impacting a satellite's orbit. Apart from these external factors a satellite will orbit on a given track. Understanding fundamentals of the orbital track allows for a greater understanding of the satellite's ground track. To fully develop the thesis topic, there are a few technical aspects associated with satellites and satellite ground tracks that merit explanation.

To determine where satellites are or where they will be at a given time, it is necessary to know the orbit size, orbit shape (eccentricity), orbit orientation (inclination), and satellite location. Understanding the dispositional relationship of these orbital elements facilitates determining the satellite's ground track. Additional effects, such as the Earth's rotation and altitude of the satellite, have bearing on the satellite's ground track. (see the associated figures 2, 3, 4, and 5 for an explanation of how these effects can impact on satellite ground tracks).

Again, this is only an elementary explanation of satellite orbit elements and ground tracks; there is a significant number of more technical factors that come into play. The importance lies primarily in understanding the various elements and the impact on positioning satellite coverage. An example of the importance of understanding these fundamentals in satellite ground tracks occurs during imagery collection. If the satellite will not travel within the satellite's optical parameters (image area ground footprint) relative to the satellite ground track, collection on the ground target area may not be

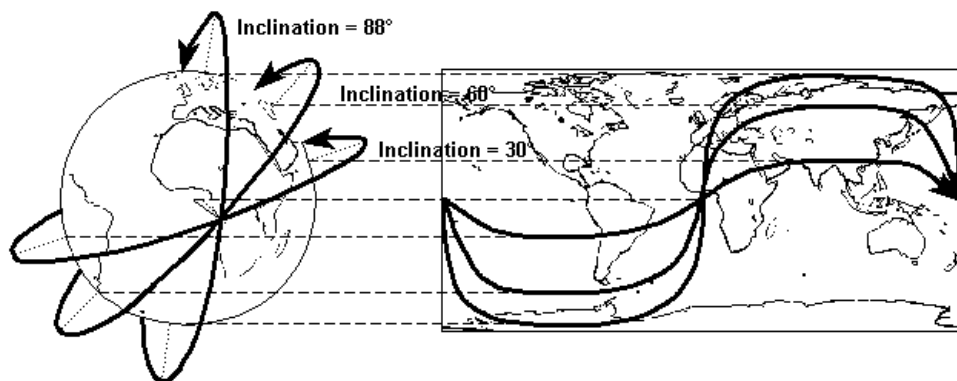


Figure 2. Effect of Orbit Orientation (Inclination) on Satellite Ground Track (Gregoire 2000, 69)

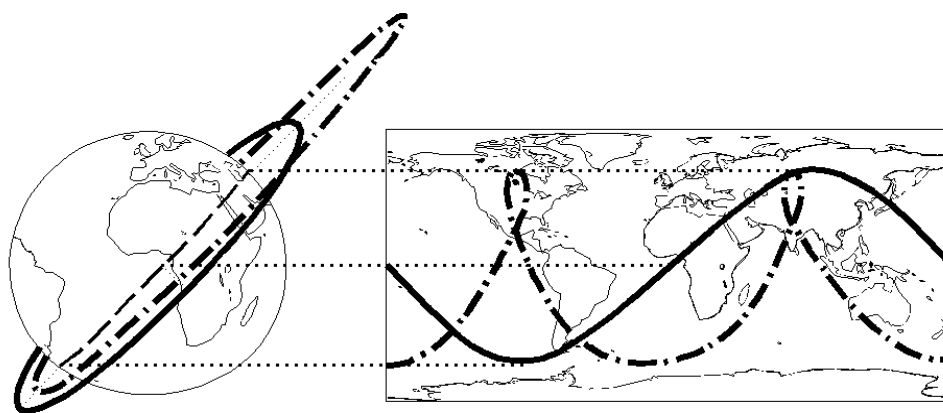


Figure 3. Effect of Orbit Size and Shape (Eccentricity) on Satellite Ground Track (Gregoire 2000, 70)

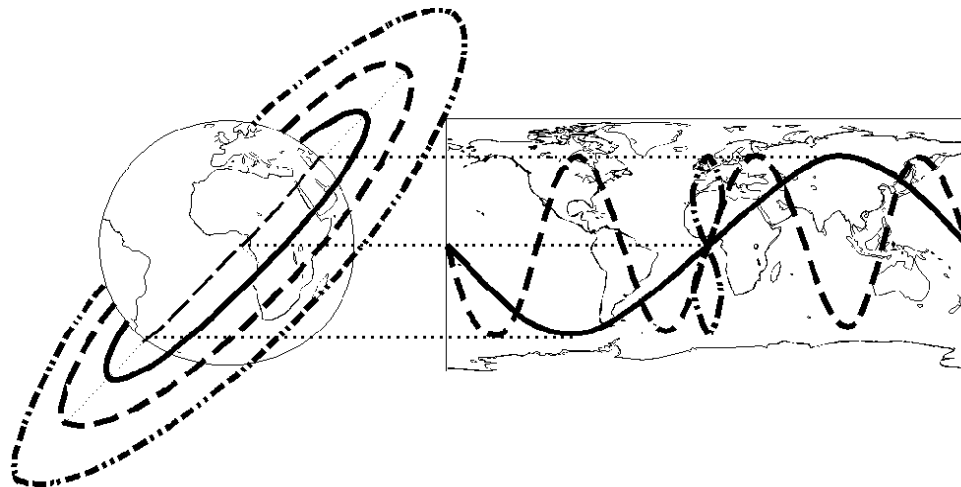


Figure 4. Effect of Altitude on Satellite Ground Track (Gregoire 2000, 70)

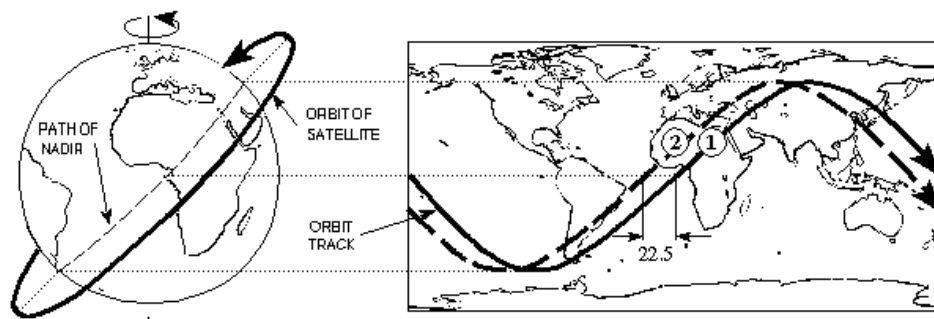


Figure 5. Effect of Earth's Rotation on Satellite Ground Track, First and Second Orbit (Gregoire 2000, 69)

possible. A possible option could be to alter one or more of the elements of the satellite's orbit to ensure its ground track covers the target area. In varying degrees, this explanation of the impact on satellite ground tracks relative to desired ground coverage holds true for other types of satellites.

Global positioning systems utilize a method of triangulating positional location between transmitters, satellites, and receivers, providing an instrument for navigation and a means for space-based electronic tracking. Global positioning system receivers and transmitters as a navigational instrument can assist in guiding users to their intended destination, while package shipments can now be tracked from their point of origin along their route to their destination. Widespread commercial availability, use, familiarity, and utility of global positioning systems have initiated the development of inexpensive receivers and processors, making their distribution and use even more widespread. Exploiting the use of this commercially available system can be a formidable enabler to the nation's adversaries.

Satellite communications systems are becoming equally widespread and are themselves potential technological enablers. The ubiquity of global satellite communications availability is largely the result of commercial investment. While commercial global satellite communications have been available for many years, only recently has the technology been miniaturized to handheld size. Previously both commercial and military satellite communications was generally limited to between 70 degrees north-70 degrees south (Karpiscak 1998, 5). What makes global satellite communications unique is the near literal pole-to-pole availability made possible by constellations of satellites orbiting along multiple planes. Handheld global

communications, coupled with access to the Internet, contribute greatly to an adversary's capabilities, the results of which are an enhanced ability to communicate, access information, and maintain a modicum of anonymity. The adjoined capabilities of commercial satellite communications and global positioning systems result in significant resources to a non-state adversary. The availability of commercial space imagery is another enabler.

The availability of commercial space imagery has increased significantly over the past several years. Currently, high-resolution imagery is available at a relatively modest price and can include terrain elevation data. Additionally, both current and archived imagery is available for purchase on the commercial market. Desktop imagery exploitation software available through industry, universities, or US government sources is also available. These commercially available products, when used collectively, offer the user the potential to yield vast amounts of information. The accessibility of high-resolution imagery, exploited using commercially available software available for purchase either through the mail or via the Internet download, reflects yet another enabling resource available to non-nation-state adversaries.

As discussed in chapter 3, the methodology involves using the proven and effective process of standard IPB, applying the added subject area of space to the analysis. Space IPB includes the same four-stepped process as standard IPB: define the battlespace environment, define the battlespace effects, evaluate the threat, and describe the threat course of action. Ultimately, the result endeavors to develop an understanding by the commander and staff of space and how it influences the entire scope of operations (Carleton 2001, 4).

Throughout the analysis the subject areas will apply to all entities involved, friendly, adversary, and third parties. In the first step of the process it is necessary to define the battlespace environment. In this step the analysis includes looking at the space threat and the environment and determining what is known and unknown about the threat and environment in general terms. In determining what is unknown during the analysis, determinations are made with respect to exactly what types of information and support must be requested from higher or supporting agencies. Here is where the broad impact of space on operations is determined (Carleton 2001, 14).

Next, the analysis must describe the battlefield effects that include space weather and the interrelationship with terrestrial weather effects. Effects include the geographical disposition of space-based and space-related assets. In simple terms, information gained from the analysis during the first step of space IPB is added to the outcome of the analysis in the second step to determine the resultant impact on operations. An understanding through the definition and analysis conducted in these two steps is the foundation from which the analysis is applied to evaluating the threat and threat's available courses of action (Carleton 2001, 15).

In the third step, the application of space as a subject area for evaluating the threat is used to determine capabilities, how the capabilities can be used, and what the threat or third parties could do to influence capabilities of all entities involved. Here the goal is to determine what aspects of space the threat can use in support of its mission. Conversely, the analysis includes determining what the threat can do to mitigate the friendly use of space and space-related assets. Again, a third party analysis is included to determine the potential impact on overall operations. The first three steps of space IPB set the stage for

describing potential threat courses of action. The cumulative data from analyzing the environment, the effects, and the threat result in the final step of the process and provide comprehensive analysis leading to the creation of intelligence products used by the commander and staff. The end result of space IPB will allow the commander and staff to understand the impact of the subject area of space and how it influences the entire scope of the operations (Carleton 2001, 34).

Phase I. Analysis: Comparative Examination

Task Force Ranger, Somalia

In May 1991, northern clans declared an independent Republic of Somaliland, which included the administrative regions of Awdal, Woqooyi Galbeed, Togdheer, Sanaag, and Sool. Although not recognized by any government, this entity maintained a stable existence, aided by the overwhelming dominance of the ruling clans and economic infrastructure provided by British, Russian, and American military assistance programs (Central Intelligence Agency 2001b, 2). However, developing civil disturbances in Mogadishu and outlying areas interfered with any substantial economic advance and with international aid arrangements, causing the country to be thrown further into dire straights. Beginning in 1993, a two-year United Nations humanitarian effort (primarily in the south) was able to alleviate some of the famine conditions that existed. Task Force Ranger was sent to the East African country of Somalia in an effort to remove Somali clan warlord Mohammed Farah Aidid from power by capturing him in order to enable the peace process and to continue the humanitarian relief effort. By this time the country was effectively divided along clan lines, where governing warlords exacted the rule. At the same time these warlords saw little in pursuit of peaceful accords and thought more of

expanding and solidifying their regional control. It is within this lawless land of severe economic, political, and humanitarian strife that the Rangers found themselves operating.

The Ranger task force established a base of operations at the Mogadishu Airport from which it conducted numerous types of missions. Included in the missions conducted by the Rangers were intelligence gathering raids, raids to capture key leaders in Aidid's command network, shows of force, and reconnaissance missions. Rangers had at their base of operations various types of rotary-wing and fixed-wing aircraft, highly mobile multiwheeled vehicles trucks, and larger troop transport trucks that they used during the conduct of their operations. Additionally, Rangers had established ammunition storage, billeting, and headquarters areas for planning and command and control functions as a part of the base's infrastructure. The Ranger base of operations was secured by a number of measures that included the use of physical barriers and static and roving guard positions.

The 11 September 2001 Attacks on the World Trade Center and the Pentagon

Already an identified terrorist, Osama bin Laden was indicted for his alleged role in the embassy bombings in Kenya and Tanzania. He and the terrorist organization Al Qaeda were suspected assailants in a number of other terrorist acts, to include the bombing of the USS *Cole* in Yemen. Osama bin Laden declared a holy war against the US based on the US presence in the Muslim Holy Land of Saudi Arabia. In general, bin Laden's overarching aim is to get the United States out of the Persian Gulf region. Osama bin Laden and his global network of lieutenants and associates remain the most immediate and serious threat. The Central Intelligence Agency characterized that since 1998, bin Laden has declared all US citizens legitimate targets of attack. As shown by the bombing

of the US embassies in Africa in 1998 and his millennium plots last year, he is capable of planning multiple attacks with little or no warning. His organization is continuing to place emphasis on developing surrogates to carry out attacks in an effort to avoid detection, blame, and retaliation. As a result it is often difficult to attribute terrorist incidents to his group, Al Qaeda (Central Intelligence Agency 2001a, 1).

Osama bin Laden and the terrorist network Al Qaeda had been receiving safe haven in Afghanistan with the help of the ruling Taliban government. Afghanistan has the distinction of being an extremely poor country, where multiple tribal organizations exercise control of various regions within the country. The terrain is generally rugged and mountainous, particularly in the areas where the Taliban and Al Qaeda strongholds exist. On 19 October 2001 Rangers conducted two raids on targets inside Afghanistan. One target site involved the Rangers conducting an airborne assault from C-130 aircraft onto an airfield in southern Afghanistan. The Rangers seized the airfield and cleared buildings in a raid that was intended to, among other things, gather intelligence (ArmyLINK News 2001, 2). At the same time in another undisclosed area of Afghanistan, Rangers participated in missions directed against a Taliban command and control facility near the town of Kandahar (ArmyLINK News 2001, 2). Rangers operated out of multiple staging areas outside of Afghanistan, to include land-staging and sea-staging bases. Up until this point in the writing of this thesis, Rangers have continued to conduct missions in Afghanistan against the terrorist Osama bin Laden, the Al Qaeda, and the Taliban.

Space IPB for Ranger Operations

Step 1. Define the Battlespace Environment

The Rangers have to determine the expanse of their area of operations (AO) and their area of interest (AI). Here the space IPB analysis for the Rangers includes all entities within the Ranger commander's area of responsibility that can exploit space. Rangers operating in Somalia and Afghanistan utilized a number of space-related systems, including communications systems, intelligence dissemination systems, and navigation systems. Later in this chapter specific Ranger systems that necessitate space IPB will be discussed and assessed. Ranger adversaries, like Aidid in Somalia and bin Laden in Afghanistan, both used satellite and cellular phone communications technologies (The Associated Press 2001, 2). In this step of the analysis, identification of the space-related systems utilized by non-nation-state adversaries is indicated. This analysis will identify the pathway of the electronic interface between the ground system and space. This pathway gives definition to the bounds of the Ranger commander's AO and AI. For example, bin Laden utilized the Internet to communicate. The method of communicating via the Internet included the use of steganography, which is the process of hiding a secret message within an ordinary message. The message is first encrypted using any number of commercial encryption technologies. Then the message is inserted by using a special algorithm into an unobtrusive electronic file format, like an image (Sieberg 2001, 2). Knowledge of an adversary's communications pathways relative to space lets the Ranger commander and his staff develop an understanding of how space influences the entire scope of operations.

Another influential aspect of the analysis includes space-related resources that are available commercially. Non-nation-state adversaries can utilize commercially available resources, such as commercial imagery and commercial software. Important here is determining the impact of commercially available resources when defining the AO and AI. If the Rangers plan to conduct operations from a single location (called a forward staging base), like they did out of the Mogadishu Airport, then the availability of commercially available resources merits significant consideration. As was the case in Somalia, the Rangers operated out of their forward staging base at the Mogadishu Airport for several months. Ranger adversaries then would have adequate time to order, purchase, and have electronically delivered via electronic mail commercial imagery on the Ranger forward staging base. Subsequently, the disposition of Ranger forces and the availability of commercial space resources affect defining the AO and AI and further shape what additional analysis is necessary for the remainder of space IPB.

In each of these situations the analysis would also include third party entities that may have systems that influence the Ranger commander's area of responsibility. Other foreign governments, international agencies, or non-nation-state entities conducting operations within the Ranger commander's area of responsibility merit consideration during space IPB. In Somalia, there were many foreign governments involved in the United Nations humanitarian relief effort that had access to space-based resources. For example, Russia was involved in the ongoing humanitarian relief effort and could have collected satellite imagery of Ranger equipment at the Mogadishu Airport to determine equipment capabilities used in certain special operations missions. In Afghanistan, with the proximity to Iran and the Iranians' likely desire to gain tactics, techniques, and

procedures of Ranger special operations, analysis can reasonably determine whether their inclusion is necessary. While this thesis is focusing on non-nation-state adversaries, the aforementioned analysis serves as a reminder that during the conduct of space IPB all entities within the Ranger commander's area of responsibility that can exploit space need to be considered.

Finally, Ranger intelligence personnel need to evaluate all existing databases that may have relevant information consistent with the planned operations. An example of a space-related database available for space IPB includes data on predictions for sunspot activity. These databases are available through open source means at www.sunspot.com (Hathaway 2001a, 2). This makes available to both Ranger planners and non-nation-state adversaries information that predicts solar activity. As indicated earlier, solar activity can directly impact the Earth's magnetosphere and correlates to the effectiveness of multiple space-related systems, including communications, global positioning systems, and commercial space-imaging platforms. The end result of this step in the space IPB is an understanding of the relationship of space in defining the Ranger commander's AO and AI and in evaluating existing databases and information relevant to space and the Ranger operation, so as to identify the intelligence information gaps. In ascertaining what is unknown during analysis, determinations are made with respect to exactly what types of information and support must be requested from higher or supporting agencies.

Step 2. Describe the Battlefield Effects

Space IPB analysis must define the battlefield effects, which include space weather and the interrelationship with terrestrial weather effects, and will include effects from the geographical disposition of space-based and space-related assets relative to the

Ranger operation. During step 2 of the analysis, space weather effects are considered because, as discussed earlier, space weather can play a significant role in the effectiveness of electronic equipment. An analysis of the solar activity archives, available to the public through the Internet by the National Oceanic and Atmospheric Administration, determined that during the months of 1993 during which Rangers were conducting operations in Somalia, the sun was undergoing a solar cycle known as a solar minimum. Conversely, during ongoing operations in Afghanistan in 2001, the sun has been in a cycle known as the solar maximum (Hathaway 2001a, 1). Why is this significant to the analysis? Every eleven years the sun completes a measurable cycle of activity that can cause fluctuations in the Earth's magnetosphere. In turn, the fluctuations in the Earth's magnetosphere can affect communications equipment on Earth. This becomes a consideration for the analysis because during periods of the solar maximum there are numerous sunspots, solar flares, and coronal mass ejections that can affect the Ranger operations in Afghanistan (Hathaway 2001a, 1). These are just a few examples for considering the possible effects of space weather on Ranger operations.

Terrestrial weather effects are a consideration long understood in the conduct of ground operations. Extreme weather conditions, like the heat in Somalia and the cold in the mountains of Afghanistan, represent effects on troops that Ranger commanders have long been familiar with. Current Ranger commanders have become more familiar with the effects of weather on technical systems, such as aircraft and the ability to see targets in the execution of close air support tasks, because of special operations reliance on detailed technical analysis. Over time, they are becoming even more aware of the general effects and alternatives to the impact of weather on imagery. Each Ranger commander

may have varying degrees of understanding of weather effects and space IPB, yet it remains the responsibility of appropriate staff representatives to fully analyze the impact and alternatives to weather on space-based systems. Cloud cover directly affects the quality of electro-optical satellite imagery. Clouds can be more prevalent in a region during certain seasons. Equally, terrain can have an impact in generating weather in a region. Large bodies of water can feed regional weather systems with moisture to create cloudy conditions. Additionally, low lying areas and temperature inversions can create ground fog. Mountainous terrain can trap fog and clouds in a particular geographical region. In Afghanistan, the effect of the change in the season between the autumn and winter is a cause for the development of ground fog. Normally occurring clouds and fog in Afghanistan that become trapped in the mountains are a serious consideration when conducting space IPB. The detailed intelligence necessary to conduct special operations, covering large distances and using precision munitions, makes this aspect of analysis important. Weather effects, like cloud cover experienced in the mountains of Afghanistan, have a direct impact on electro-optical imagery and necessitate considerations for alternate means of space-based collection, such as radar or thermal imagery. Subsequently, terrestrial weather conditions are a factor for the Ranger commander conducting operations in Somalia or Afghanistan.

Another factor in space IPB is the effect from the geographical disposition of space-based and space-related assets relative to the Ranger operation. During operations in Somalia the relatively flat or rolling terrain was more conducive to the general interoperability of ground and space assets. However, operations in Somalia took place largely within the confines of built-up (man-made structures) areas within the city of

Mogadishu. The line of site between the ground and space-based assets is necessary for interoperability, and the built-up areas of cities can quickly degrade or marginalize space-related equipment interoperability. Terrain masking affects the accuracy of global positioning systems within a built-up area and may necessitate alternate control measures to facilitate ground navigation.

The same considerations are necessary in the mountainous terrain of Afghanistan, where the line of site between ground-based and space-based assets can impact global positioning system effectiveness. Within the Ranger commander's AO in Afghanistan are numerous cave networks and man-made structures that exist amidst the mountains. The interoperability of ground-based and space-based assets, like communications and imagery systems considered when planning the operational disposition of friendly and enemy forces, shapes an understanding of the battlefield's effects on operations for the Ranger commander and his staff. From here the Ranger commander and staff determine whether to modify the location of friendly forces relative to the enemy, request the technical maneuver of satellites, or request additional satellite coverage based on the technical need (global positioning systems, satellite imagery, or satellite communications). Imagery analysts routinely request modifying the ground footprint of satellite platforms to enhance the desired effects of the end product. The Al Qaeda and bin Laden are utilizing caves in the mountainous areas in Afghanistan because of the perceived security from observation and because of the protection from aerial bombing (Schrader 2001, 1). In this instance, obtaining radar or thermal imagery of a cave entrance in Afghanistan may necessitate reorientation of the satellite. Additionally, pilots using global positioning system guided munitions may alter flight routes in order to

accurately deliver their ordnance to the target. Subsequently, in Somalia amidst the city of Mogadishu and in the mountains of Afghanistan, a factor in space IPB includes the effects from the geographical disposition of space-based and space-related assets relative to the Ranger operation. Understanding through definition and analysis conducted in describing the battlefield effects establishes the foundation from which the analysis is applied to evaluating the threat.

Step 3. Evaluate the Threat

As previously discussed, when evaluating the threat it is necessary to determine capabilities, how the capabilities can be used, and what the threat or third parties could do to influence capabilities of all entities involved. The goal is to determine what aspects of space adversaries can use in support of their mission. Additionally, the analysis includes determining what the threat can do to mitigate the friendly use of space and space-related assets. Space-related priority intelligence requirements (PIR) are developed from this step in the evaluation process to assist in developing the collection plan. The first area we will cover in evaluating the threat is determining capabilities.

The capabilities of non-nation-state adversaries to exploit space are limited only to their imagination, awareness of the means, and a limited degree of technical understanding of the subject. Whether or not adversaries choose to exploit space is another matter for consideration. Determining if adversaries will use space will involve assessing how it will be exploited, their likelihood of using space, and the impact to Ranger operations. If it is determined an adversary will use space in some capacity, what is the risk to the Ranger force's operation? Then, what if anything should be done to mitigate the risk either through offensive actions or defensive protective measures?

The terrorist events of 11 September are extraordinary examples of this topic. A contractual agreement between the United State's Department of Defense and the commercial space-imaging company Space Imaging was recently made. The National Imagery and Mapping Agency, a branch of the Department of Defense, bought all the rights to the entire capacity of the satellite to take photos of Afghanistan and nearby countries taken by Space Imaging. The IKONOS satellite taking those images has a resolution of one-meter detail (Gordon 2001, 2). This is enough definition from a satellite image to determine vehicle size, roadways, and the presence of people on Earth. With a degree of technical training this level of image resolution can determine even more. The reasoning for this contractual agreement has not been revealed beyond the guise of operational security; however, the act offers an opportunity for pertinent discussion.

Since the imagery from Space Imaging is commercially available, then anyone with a credit card and an electronic-mail account or mailing address would be able to utilize this resource. Any entity could exploit the use of the images, so determining how the resource could be used and the impact on Ranger operations merits additional analysis. First, the analysis will cover the use of commercial imagery by the Rangers.

In Somalia, during the 3 October 1993 raid, intelligence derived from human sources, known as HUMINT, were used to identify the location of target buildings for the assault force (Bowden 1999, 28). In instances when the Rangers are working with individuals who cannot have access to classified materials, the use of unclassified commercial imagery can be used to coordinate operations. If the HUMINT source is not completely familiar with a proposed AO then familiarization can be gained with the use

of unclassified commercial imagery. Equally, in the case of operations in Afghanistan when operational coordination is being made with coalitions or tribal alliances, the imagery can be distributed on a larger scale.

It is possible that the US did not have many mapping resources of Afghanistan to share with coalition or alliance partners. Although many Russian-made maps likely exist from operations by the former Soviet Union inside Afghanistan during the 1980s, these resources may also be limited in availability.

Subsequently, the commercial imagery can even be distributed in lieu of map resources or to augment dated topographical maps. These are only a few representative examples for the use of commercially available satellite imagery for the Rangers. An article in the *New York Times* indicated that the National Imagery and Mapping Agency officials said that the purchase of the commercial satellite imagery supported the American military operation in Afghanistan and supplemented US spy satellites (Gordon 2001, 2). Therefore, it may be necessary for the Rangers to use a commercial space-based imagery resource to augment limited or already tasked national space-based collection capabilities. Of equal consideration during step 3 of the space IPB process is determining the impact of the Ranger adversary's use of commercial space-based imagery.

The driving factor behind the National Imagery and Mapping Agency's contractual agreement with Space Imaging concerning operations in Afghanistan may be based on national-level concerns. Following the Gulf War and the Kosovo air campaign, the Department of Defense received a great deal of scrutiny on the effectiveness of its targeting and the seemingly exaggerated successful post-mission reporting on battle

damage assessments (BDA). A concern for the president and the Department of Defense is popular support for military action, both from the public and from within the government. If the Al Qaeda and Osama bin Laden could access commercial satellite imagery of a bombed house, mosque, school, or international aid facility replete with other indications of helpless civilians, it is possible that these non-nation-state aggressors could exploit the images for religious, political, or international support against US military actions. While largely viewed as a national political and military level concern, we can still reason the impact to Ranger operations. Assuming the reactions are wholly negative, they could generate a backlash of myopic public, political, and military scrutiny; create risk aversion for politicians; and, subsequently, produce restrictive conditions on the use of force in Ranger operations. Consequently, non-nation-state adversaries could use the commercially available satellite imagery to shape an information campaign, as an instrument of power, against the United States and its partners.

The national public and political response to the deaths of eighteen Americans following Ranger operations on 3 October 1993 in Somalia closely relates to the type of backlash that can occur. Images of an American prisoner of war named Michael Durant and the body of an American soldier being dragged through the streets of Mogadishu sharply impacted support for continued Ranger operations in spite of the success of the raid itself. Satellite television broadcasts of these events create opportunities to learn and prepare for future operations, where the need to maintain national, and international support at all levels is so important.

Tactical-level space IPB would have determined that adversaries could exploit details to enhance their ability to conduct offensive and defensive operations. A tactic in Somalia for Aidid's fighters was the use of mortar attacks in a type of hit-and-run technique against the Ranger's forward staging-base located at Mogadishu Airport. The effectiveness of this tactic was quite literally hit and miss. Without a great deal of technical training in the geometry of indirect fire, the enemy used a technique called direct lay of the mortar tube. Here the enemy would target the Ranger troops and equipment at the airport by setting up the mortar tube and estimating the range to the target area, and make estimations on elevation and deflection of the mortar tube based on the original range estimations. With some practice, an enemy can gain a degree of efficiency using direct lay tactics. Having limited technical efficiency in mortar operations made the direct lay method viable, as did the limited exposure of the mortar team, because of the speed gained from nontechnical estimations. The Rangers occupied a static base at the Mogadishu Airport for several months. This gave Aidid and his forces an opportunity to obtain satellite imagery of the Ranger forward staging base at the Mogadishu Airport. In this case the imagery becomes an enabler for the mortar attacks. Using the imagery can increase accuracy of the direct lay of mortars through improved estimations. Estimating the lengths of visible objects, like fencelines evidenced in the imagery, becomes a tool for establishing known distances during mortar missions. Coupled with practice gained in trial and error, determining ranges using estimated distances measured off of known lengths of objects in the imagery makes the initial mortar rounds more accurate. Subsequently, corrections to the relatively precise initial fires improve accuracy in adjusting the latter rounds.

Directing other information-gathering efforts based on details gained from imagery are an added example of how commercially purchased imagery can become an enabler. Having obtained and studied the overhead imagery, the HUMINT source can use the imagery to select locations from which to observe the airport, determine numbers of personnel boarding aircraft, determine numbers and types of aircraft being used, observe flight operation routines, and report on the launch of air operations as they occur. The potential adversary then monitors the airport and, knowing the launch times, size, and composition of the force, is able to report, so the enemy can prepare either defensively or counteroffensively for the Ranger force's arrival. Additionally, a HUMINT source can be dispatched to the area nearby the airport and determine locations for concentrations of Ranger personnel and determine the disposition of parked aircraft and equipment in an effort to identify high-payoff targets for mortar attacks. Furthermore, enabling commercial satellite imagery can be used in conjunction with other forms of information to develop what cumulatively is called intelligence for suicide terrorist attacks against Rangers in the forward staging base. There is virtually no end to the use of commercially available satellite imagery when used by non-nation-state aggressors as an enabler to their operations. Only an aggressor's imagination, awareness of the means, and a limited degree of technical understanding are needed to exploit this capability.

Already discussed has been the use of some space-based communications systems by non-nation-state adversaries. In addition to Aidid and bin Laden's use of satellite and cellular phones and of the Internet, there are commercial satellite communications systems they can use. It is a reasonable conclusion that, given an adversary's evidentiary

use of space-based enabling technologies, other space-related technologies, like commercial satellite communications systems available to the public, could be used. Although analysis may not have any specific historical indications of an adversary's use of satellite communications, given historical knowledge that the likes of Aidid and bin Laden have used other space technologies, it is prudent to request an analysis of the radio frequency spectrum within satellite communications ranges. There are multiple forms of commercial satellite communications available; therefore, the analysis may be time consuming, yet no less necessary to thorough space IPB.

Another space-based capability available to non-nation-state aggressors is global positioning systems. Global positioning systems are yet another enabling capability that adversaries can use against the Rangers either separately or in conjunction with other space-based technologies. Although commercial global positioning systems are not as accurate as military global positioning systems, they still represent a navigational tool that can be used to enhance an adversary's operations. While bin Laden may use indigenous personnel familiar with the terrain in Afghanistan to navigate from place to place, this does not preclude the utility of commercial global positioning systems in navigating unfamiliar terrain. As an enabling technology to non-nation-state aggressors, global positioning systems do not seem that significant. However, when combined with other forms of enabling technologies, the cumulative capability may prove to be a greater threat to Ranger operations.

The real threat to Ranger operations comes from an adversary's capacity to hamper the Ranger force's use of global positioning systems and communications technologies. As indicated earlier, if there are limited map resources available in a given

AO, global positioning systems become that much more important to navigation. Rangers operating in unfamiliar terrain, such as in the streets of Mogadishu and in the mountains of Afghanistan, would rely more heavily on global positioning system-assisted navigation. Global positioning system signals are communications signals and are susceptible to the same interference as other forms of communications systems. Terrain, like the built-up areas in Mogadishu and the mountains of Afghanistan, can interfere with the global positioning system signal. Interference from frequency bleedover of other communications systems can occur. Space and terrestrial weather can hinder the global positioning system signal in the same manner they affect other communications. Finally, jamming can interfere with the relatively low power global positioning system signal (Gregoire 2000, 209). There are commercial companies, such as Aviaconversia, that are offering portable global positioning system jammers for less than \$4,000 (Gregoire 2000, 209). With capabilities like this, Aidid or bin Laden could move jammers to within proximity of high-payoff targets in order to interfere with global positioning system ground and air navigation systems, as well as global positioning system-guided munitions. The same can be done to interfere with Ranger communications systems and is of equal, if not greater, concern. Fortunately, jamming of any kind provides its own electronic signature, is relatively easy to detect, and, when identified and planned for through thorough space IPB, can be targeted for destruction.

Another commercially available capability not yet discussed is the use of commercial software to track the satellite disposition. This capability can yield the location of satellites relative to ground position. Coupled with amateur satellite observation and tracking clubs throughout the world and accessible for interface through

the Internet, relatively accurate assessments can be made to determine the type of satellite and where and when it will be over a specific target area. The utility to a non-nation-state adversary comes by ceasing or shielding actions at the time of satellite overflight in order to protect or conceal activity on the ground from detection. Conversely, Rangers can protect many of their actions from commercial overhead imagery collection by requesting technical information via satellite reconnaissance advance notice reports that provide information on times, types, and sponsors of satellite overflight. If an aggressor is savvy enough to regard as necessary hiding his actions from satellite collection or if it has been assessed that an aggressor utilizes satellite imagery as an enabler, then these types of analytical considerations become necessary.

Arguably the most difficult and time-consuming step in the space IPB process, evaluating the threat, ultimately determines capabilities, how the capabilities can be used, and what the threat or third parties could do to influence capabilities of all entities involved. With the goal being to determine what aspects of space a non-nation-state adversary, like Aidid or bin Laden, can use in support of his mission, the analysis includes determining what the threat can do to mitigate the friendly use of space and space-related assets in the execution of the Ranger mission. Space-related PIR are developed from this step in the evaluation process to assist in developing the collection plan. Some representative space IPB generated PIR for operations against non-nation-state aggressors include the following:

1. What communications network with space-based interface exists in the operational area?

2. What information is passed over the aforementioned communications network?
3. Does the US have any "shutter control" authority, or "first rights of refusal" agreements with commercial satellite providers for services if needed?
4. What space-related capabilities have the aggressor used?
5. How can the aggressor actively hamper Ranger force use of space-related resources?

A perceptive, detailed, and integrated analysis is conducted in the space IPB steps of defining the battlespace environment, describing the battlefield effects, and evaluating the threat establishes the groundwork for determining the threat course of action (COA).

Step 4. Determine Threat COA

The cumulative data from analyzing the environment, the effects, and the threat result in a comprehensive analysis leading to the creation of intelligence products used by the Ranger commander and his staff. First it is necessary to estimate the adversary's most likely objectives and endstate and from this analysis apply the analysis from the first three steps of the IPB process to determine the full set of COAs available (US Department of the Army 1994b, II-54). This will lead to the development of a situational template depicting the adversary's most likely COA, considering all effects, capabilities, vulnerabilities and time. The situational template is made up of what is known about how an adversary fights, application of the terrain and weather effects (remembering that this is an analysis of multidimensional effects, including space as terrain and space weather effects), and an adversary's COAs. Once all of the situational templates are completed, they are consolidated to produce the event template. The development of the

event template forms the framework for the collection plan by depicting where activity will identify what COA the enemy has adopted. Finally, this leads to the Ranger staff's collective effort to develop a decision support template that would fully consider space as an added dimension to the analytical framework. FM 34-130, *Intelligence Preparation of the Battlefield*, notes some considerations that can be applicable to both space IPB and non-nation-state adversaries. Those considerations include "other" characteristics of the battlefield like:

1. Politics
2. Ignorance of the military arts and sciences
3. Immature or unrefined decision making
4. Uncertainty to friendly disposition or intent
5. Unexpected objectives or desired endstates
6. Desperation
7. Bureaucratic inefficiency
8. Audacity

The end result of space IPB would allow the commander and staff to understand the impact of the subject area of space and how it influences the entire scope of the operations.

Phase II. Analysis: Ranger Regiment Space-Related Systems

Communications

AN/GRC-193. A vehicle-mounted voice and data over-the-horizon communications system that uses secure and nonsecure high-frequency radio signals.

AN/PRC-90, PRC-104, PRC-112, PRC-119, and PRC-148 Improved High-Frequency Radio Set. A man-portable over-the-horizon communications systems that use secure and nonsecure high-frequency radio signals.

AN/VRC-90 Improved High-Frequency Radio Set. A vehicle-mounted over-the-horizon communications systems that use secure and nonsecure high-frequency radio signals.

Integrated Meteorological System (IMETS). A weather data communications system that can receive, process, and disseminate weather observations, forecasts, and effects.

AN/PSC-5 Enhanced Man-Pack Ultrahigh Frequency Tactical Satellite Communications Terminal. A lightweight, man-portable, ultrahigh frequency transceiver that provides voice and data satellite communications.

AN/PSC-11 Lightweight Line-of-Site Satellite Terminal. An ultrahigh frequency transceiver providing voice and data satellite communications.

AN/GSC-59. An ultrahigh frequency transceiver providing voice and data satellite communications.

Navigation

AN/PSN-11 Precision Lightweight Global Positioning System Receiver. A global positioning system providing grid coordinate, altitude and elevation, velocity, time and direction of movement.

Notable here in the analysis is the fact that the classified table of organization and equipment present a broader list of space-related systems used by the Ranger regiment. Those that will be highlighted are represented in the unclassified table of organization and equipment and are not indicative of all space-related Ranger systems. Additionally, identification of the integrated meteorological system comes from personal experience.

The Ranger regiment has an Air Force weather detachment attached to the headquarters to provide the necessary weather support to operations. The integrated meteorological system is accounted for on Air Force organizational tables and is not included in the Ranger table of organization and equipment, but is a space-related system inherent to Ranger operations. Finally, notable is the fact that the Rangers can use any of a number of attack, transport, and support aircraft that rely on communications and global positioning systems, to include global positioning system-guided munitions, during the conduct of their operations. While not in the Ranger equipment inventory, many of these external platforms and systems are routinely task organized to the Rangers for the execution of operations.

Above are the Ranger systems that merit consideration during space IPB. Because the frequency ranges for the communications, weather, and global positioning systems identified operate in the high frequency, ultrahigh frequency, and superhigh frequency ranges they are all affected by the effects of space weather in varying degrees. All systems are susceptible to signals detection by an adversary through technical electronic analysis; however, the data being transmitted are secured by various encryption methods. All systems represent a means of transmitting and receiving information and, as such, are susceptible to jamming and deception measures, such as electronic spoofing. The best method for identifying the potential origin of interference to space-related systems from space weather or terrestrial weather, man-made interference, terrestrial interference, intercept, jamming, or deception is preparedness through detailed space IPB. A method for ensuring protection includes the use of sound communications procedures, awareness of space weather effects to troubleshoot ongoing operations, and awareness of

adversary capabilities and prior use of man-made interference and deception devices.

There are a number of trained Army personnel and organizations that can provide a space-based analysis to the Ranger regiment.

A comparative examination of space IPB, utilizing situational vignettes as a basis for assessing space as a component to IPB for Ranger operations when facing non-nation-state adversaries, noted the potential uses of commercially available space-related resources that serve to enable both an adversary's capabilities and those of the Ranger regiment. The comparative examination further noted implications for understanding the environment of space and space effects on global positioning systems, communications, and other satellite and ground-based space systems. Fundamental discussions on satellite systems and orbital mechanics noted implications for having an understanding of both of these topical areas. Identification of space-related systems used by the Rangers that merit consideration for space IPB analysis was recognized in this chapter. The comparative examination of space IPB in the situational vignettes, the fundamental discussions on satellite systems, and orbital mechanics, coupled with identification of space-related systems used by the Rangers and implications for understanding the environment of space and space effects, noted collective implications for space as a component of IPB analysis when facing non-nation-state adversaries. While operations against the Somali warlord Mohammed Farah Aidid have since been terminated, the current operations of the US military against Osama bin Laden and the Al Qaeda network continue. Given the worldwide presence of the Al Qaeda network, Rangers could potentially find themselves back in Somalia or other regions favorable to non-nation-state adversaries.

CHAPTER 5

CONCLUSIONS AND RECOMMENDATIONS

Rangers have unique characteristics that give commanders the added flexibility necessary to successfully accomplish missions that conventional forces are incapable of executing. To conduct operations directed against high-value targets that have a high degree of physical and political risk, Rangers rely on surprise, security, and audacity. Doing this means operations are usually conducted at great distances from operational bases, necessitating robust communications and mobility; these missions often require precision and discriminate use of force and weapons. Ranger operations necessitate detailed intelligence, detailed knowledge of the target AO and the effects of the environment, and detailed knowledge of their adversary's capabilities and how they can be employed. The availability of commercial and military communications, navigation, and intelligence systems that operate in space enables Ranger operations. Equally, there are enabling commercial and open-source space resources available to non-nation-state adversaries.

Following a proven systematic approach to analyzing the threat and environment of previous and current operational situations displayed numerous submissions for the application of space IPB to 75th Ranger regimental operations when facing non-nation-state adversaries. As demonstrated in the analysis, there is a myriad of open source and space-related resources available to non-nation-state aggressors. The analysis indicates Ranger adversaries have been proven to use an abundance of space-related resources. The analysis further proved the potential utility of space-related resources to a non-nation-state adversary. The growth of space system vendors, coupled with commercial

space communications systems, the Internet, and advanced microprocessors, will make imagery, navigation, and communications information easier for Ranger adversaries to obtain and effectively utilize (Karpiscak 1998, 10). Likewise, the analysis indicates the Ranger regiment employs a significant number of systems directly related to space by function and by the effects of space. Space systems will continue to be developed and will improve war-fighting capabilities of the Ranger regiment, but it will also improve the capabilities of their adversaries. Subsequently, space is a real and necessary dimension that merits detailed attention in the application of space IPB to Ranger operations.

Conclusion

Based on the results from applying the process of space IPB to 75th Ranger regimental operations when facing non-nation-state adversaries, the abundance of open-source and commercially available space-related resources to an adversary and the number of systems used by the Rangers identified as being directly related to space by function and the effects of space, this thesis concludes that Ranger operations against non-nation-state adversaries necessitate formal consideration of space IPB. Space IPB is intended to make the Ranger commander and his staff aware of the impact of every aspect that the environment and an adversary can have on the execution of operations. Some degree of technical understanding or at least awareness of the effects that solar, electromagnetic, geophysical, and radiation activities can have on space-related systems (global positioning systems, communications, radar, navigation, and intelligence collection) is necessary to completely plan and execute Ranger operations. Advanced knowledge of high levels of solar activity affecting the magnetosphere resulting in potential damage or degradation of global positioning systems, communication systems,

intelligence collection platforms, and radar systems necessitates analytical and operational planning considerations. This understanding and awareness can save valuable time for the Ranger staff and space system operators in troubleshooting problems from space-related effects and an adversary that may arise during operations. Likewise, awareness of the space-related resources available to an adversary and of the scope of what they can do with them necessitates consideration in planning and execution in order to achieve preparedness. Arguably the most often overlooked aspect of space IPB includes those space-related resources and capabilities that are available to any non-nation-state adversary having the wherewithal to exploit space as an operational enabler. Space IPB for the Ranger commander and his staff can then help them make informed decisions when planning and executing operations, and the staff can then begin to develop tactics, techniques, and procedures to exploit and integrate knowledge gained from an understanding of space and its effects. Space represents the current and undoubtedly future key terrain in Ranger operations. Conclusively, space IPB of operations when facing non-nation-state aggressors can better serve the Ranger commander and his staff in the overall cycle of the military decision-making process.

Recommendations

Ranger operations are unique. Where it would be expected that the Rangers would receive space IPB support from a supported higher headquarters, Ranger capabilities, limitations, tactics, techniques, and procedures may not be fully recognized by the supported higher headquarters, thereby necessitating that the Rangers do their own space IPB analysis. At a minimum this will ensure that the Rangers are asking the supported higher headquarters the appropriate space-related requests for information and,

based on the mission, are considering the space-related intelligence requirements. The Rangers are better served by having an awareness of the implications of space IPB when facing non-nation-state aggressors, as opposed to relying on an external agency like a supported higher headquarters. The United States Army Intelligence Center and Fort Huachuca are already beginning to implement formal instruction on space as a component of military operations. From this pool of school-trained officers the Rangers will select members for assignment to the Ranger regiment. Subsequently, future Ranger officers will have a greater degree of understanding for the implications of space as a component of IPB. In the interim, to ensure that their needs are being met, Ranger intelligence officers need to conduct self-study, coach fellow Ranger staff members, and, as a temporary solution, specifically ask for space IPB support to military operations from external and supported elements. Rangers can attend an introductory space orientation course offered by the US Space Command as a stopgap in bridging their staff's lack of internal space expertise or as a refresher to developing space issues.

Knowledge that there are joint and service space support teams assigned to provide space expertise, advice, and liaison to theater commanders, theater headquarters, and joint task forces will aid in planning Ranger operations. US Space Command Space Operations Center is manned twenty-four hours a day as a resource for obtaining space support. Also, Army space operations officers (FA 40) are assigned to theater, division, and corps staffs to handle activities regarding war-fighting implications of space operations and support. Ideally, the Ranger regiment would seek an FA 40, space operations officer or an officer with the 3Y, space activities officer identifier for

assignment directly to the regiment for resident, organic space support (Gregoire 2000, 244).

The Army Space Support Team is an element of US Army Space Command organized and resourced to support space-related needs of commanders and staffs. ARSST can support Ranger operations in a number of ways. The Army Space Support Team can provide satellite reconnaissance advance notice data that indicate potential adversaries or commercial satellite systems and their capability to monitor Ranger operations. The Army Space Support Team can provide guidance and advice on the degree of accuracy of global positioning system-related data and on the possible countermeasures to adversary efforts to jam or spoof global positioning systems. Space weather data detailing the potential effects to space-related systems are also available. Imagery products provided by the Army Space Support Team include capabilities that exceed most internal topographic units and provide the Rangers with an additional agency from which to request imagery support when internal assets are tasked to capacity. The Army Space Support Team can provide limited supplement to the unit's early entry communications connectivity using satellite phones, international maritime satellite hand-carried terminals. Finally, the Army Space Support Team can provide space intelligence support via the US Army Space Command Deputy Chief of Staff, Intelligence members in response to space-related requests for information, assessments on adversary use of space or space systems, and additional expertise on US force's space-based intelligence capabilities (US Army Space Command 2001, 1). Ranger planners can provide the operational advice as the interface to coordinating space support from each of these resources.

This thesis focused on an unclassified analysis of space IPB when facing non-nation-state aggressors applied to Ranger operations. Those familiar with the Ranger regiment and the classified nature of its command architecture, operations, equipment, tactics, techniques, and procedures will perhaps better understand the full impact of the analysis discussed. As the Rangers and their adversaries continue to exploit space-based capabilities, it would be beneficial to conduct an analysis of this topic at the classified level.

GLOSSARY

- Atmosphere.** The envelope of air that surrounds Earth. Prompt effects on reentry vehicles begin about 60 miles above the surface. Prompt effects on ascending spacecraft and ballistic missile end at the same altitude (Collins 1989, 146).
- Circumterrestrial Space.** A region that abuts Earth's atmosphere at an altitude of about 60 miles and extends to about 50,000 miles. Most military space activities currently occur therein. Sometimes called inner space (Collins 1989, 147).
- Concealment.** Actions and conditions that prevent enemy observation, but provide no protection against weapon effects. Clouds, camouflage, and stealth technology are representative (Collins 1989, 148).
- Cover.** Physiographic conditions that protect targets against enemy weapons and adverse environments. They also prevent observation. Terrain masks and subterranean installations on Earth, its moon, or another planet are representative (Collins 1989, 148).
- Deception.** Measures designed to deceive enemies. They may build faith in false images or increase ambiguities, so foes do not know what to believe (Collins 1989, 148).
- Decoy.** An object that simulates a particular type target (spacecraft; missile warhead), employed to deceive enemy sensors, and thereby divert attacks (Collins 1989, 148).
- Electromagnetic Radiation.** A wavelike phenomenon that consists of a variable electric and variable magnetic field that combine to transport energy through the vacuum of space. Flux per unit area is greatest near our sun and the stars (Collins 1989, 150).
- Electronic Warfare.** Use of the electromagnetic spectrum to degrade enemy capabilities, and activities that prevent opponents from using the electromagnetic spectrum effectively for offensive or defensive purposes (Collins 1989, 150).
- Ionosphere.** A region of electrically charged (ionized) thin air layers that begins about 30 miles above Earth's atmosphere and overlaps the lower atmosphere. The maximum concentration of electrons occurs at about 375 miles. Effects on high-frequency radio propagation are important (Collins 1989, 153).
- Key Terrain.** Physical features, natural and artificial, the seizure, retention, destruction, or indirect control of which would confer a marked advantage on a country or coalition. Critical installations and orbits are representative (Collins 1989, 153).
- Magnetosphere.** A vast region dominated by Earth's magnetic field, which traps charged particles, including those in the Van Allen belts. It begins in the upper

atmosphere, where it overlaps the ionosphere, and extends several thousand miles farther into space (Collins 1989, 155).

Mesosphere. Earth's atmosphere 30-50 miles above its surface. Temperature inversions that occur in the stratosphere cease. Readings of -100 degrees F are normal.

(Collins 1989, 155)

Orbital Mechanics. Physical laws that control spacecraft flight paths and missile trajectories through space. Conservation principles of angular momentum and energy in a gravitational field figure prominently (Collins 1989, 156).

Outer Space. All of the Earth-Moon System except circumterrestrial space. It extends from about 50,000 miles above Earth's surface to about 480,000 miles (Collins 1989, 157).

Signature. Distinctive signals (such as electromagnetic radiation) that any object emits or reflects, which sensors use to detect, locate, identify, an/or track targets. Each type of ballistic missile, for example, trails a characteristic exhaust "plume" during powered flight (Collins 1989, 160).

Soft Kill. Weapon effects that penetrate targets without breaking the surface, then damage or destroy internal components. Violence is not evident to observers. Electromagnetic pulse and neutral particle beams are representative instruments (Collins 1989, 161).

Solar Flares. Spectacular, pervasive outbursts of energy that emanate periodically from our sun, accompanied by high-speed protons that comprise a potentially lethal radiation hazard to any unshielded form of life in space. Intense and sudden ionospheric disturbances also occur, with fadeouts and other debilitating effects on long-range telecommunications. Major flares may last from a few minutes to several hours (Collins 1989, 161).

Solar Wind. A constant plasmic flow of low-energy charged particles in all directions from our sun. Velocities and densities vary with sunspot activity. Radiation hazards are significant, but minor compared with solar flares (Collins 1989, 161).

Spoofing. A form of ECM or ECCM deception that fools enemy command and control systems by sending false electronic signals (Collins 1989, 163).

Stratosphere. Earth's atmosphere 10-30 miles above its surface. Life-support systems are essential. Temperatures decrease with altitude in lower layers, but inversions occur at the top, where maximum readings reach about 45 degrees F (Collins 1989, 163).

Thermosphere. Earth's thin atmosphere 50-300 miles above its surface. Tremendous inversions cause temperatures to increase dramatically. Peak readings near the

top may reach 2,250 degrees F. Diurnal variations probably are several hundred degrees (Collins 1989, 164).

Troposphere. Earth's atmosphere from the surface to about 10 miles above the equator and half that altitude near the poles. This is where most clouds, winds, precipitation, and other weather effects occur (Collins 1989, 165).

Van Allen Belts. Two intense radiation layers trapped in Earth's magnetosphere from 45 degrees N to 45 degrees S latitude. The lower layer begins between 250 and 750 miles above the Earth's surface and tops 6,200 miles. A low particle slot separates it from the upper layer, which terminates at 37,000-52,000 miles, depending on solar activity. Protons are most prominent at 2,200 miles. Electron flux peaks at approximately 9,900 miles. Spacecraft need shielding to transit safely (Collins 1989, 166).

X-Rays. Electromagnetic radiation with wavelengths shorter than 10 nanometers (10 billionths of a meter). Nuclear explosions are one potent source (Collins 1989, 167).

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